

**FLINT/AMBER LAMINATED GLASS CONTAINER
AND METHOD OF MANUFACTURE**

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The present invention is directed to glass containers for food products and the like, and more particularly to a laminated glass container and method of manufacture in which the glass 5 layers are of chemically incompatible composition, such as an oxidized flint glass outer layer over a reduced amber glass inner layer.

Background and Objects of the Invention

Glass containers are conventionally provided of either clear or colored construction. Clear containers of flint glass composition, for example, are employed for enclosing 10 food products in applications in which it is desirable to be able to view the product through the container wall. On the other hand, amber glass is employed for products such as beer, for example, so that the absorption properties of the glass will decrease transmission of light wavelengths through the container that potentially might degrade the product.

It is also known that flint glass and amber glass are reactive with each other due 15 at least in part to the differing oxidation states of these glasses. One accepted technique for quantifying these differing oxidation states involves use of a so-called "redox number" as described in Simpson and Myers, "The Redox Number Concept and Its Use by the Glass Technologist," *Glass Technology*, Vol. 19, No. 4., August 4, 1978, pages 82-85. Amber glass may be characterized as a reduced glass, having a redox number in the negative range. On the 20 other hand, flint glass may be characterized as an oxidized glass, having a redox number of zero or above. The chemistry for the amber glass coloration is complicated, and is believed to include a complex chromophore of ferric ion and sulfide ions, which is formed in a reducing atmosphere.

At forming temperatures at which the glasses are molten, the flint and amber glasses will react with each other forming bubbles or foam in an oxidation/reduction reaction. It is thus necessary when converting a glass container manufacturing line from manufacture of flint glass containers to amber glass containers, for example, fully to remove any residual flint glass in the furnace and 5 forehearth equipment to avoid formation of bubbles in the amber glass containers through redox reactions within the amber glass.

U.S. Patent 4,740,401 discloses an apparatus and method for forming laminated glass containers that comprise an inner core glass surrounded by an outer skin or casing glass. The techniques disclosed in this patent have been employed for manufacture of flint glass 10 containers - i.e., containers having a core layer of flint glass surrounded by a casing layer of flint glass having a lower coefficient of thermal expansion so that, on cooling, the casing layer is placed under compression and provides additional strength to the overall container sidewall. However, problems are to be anticipated when it is considered to employ this technology to form containers having an amber would glass core layer surrounded by an amber glass casing layer. The lower 15 radiation heat transfer characteristics of amber glass make temperature control more difficult for the casing glass because of the relatively low flow rate of the casing glass. Furthermore, any residual flint glass or other contaminants in the casing glass forehearth or other flow equipment could cause production of seeds and blisters through redox reactions for reasons previously indicated. Moreover, the reduced glass composition of the amber glass may cause erosion of 20 precious metal layers of platinum and rhodium in the glass melting system. There would also be substantial expense associated with more frequent replacement of casing glass flow equipment when used with amber glass rather than flint glass. It is therefore a general object of the present invention to provide a method of forming a laminated glass container that addresses one or more of these problems. Another and more specific object of the invention is to provide a method of

constructing a laminated amber glass container. A further object of the present invention is to provide a glass container formed by such method.

Summary of the Invention

Briefly stated, and by way of summary and not limitation, it has been found in accordance with the present invention that laminated glass containers of the character described above can be formed with an inner core layer of amber glass and an outer casing layer of flint glass employing manufacturing equipment and techniques of the type shown in U.S. patent 4,740,401 without producing blisters or bubbles at the interface between the amber core and flint casing layers. Specifically, it has been found that, employing such equipment and technology, the total time duration during which the flint and amber glasses are together at reactive (molten) temperatures is sufficiently small that the glass containers will be cooled below molten glass temperatures before the redox reactions have an opportunity to occur. Thus, laminated glass containers are provided having an inner core layer of amber glass and an outer casing layer of flint glass without production of the blisters or bubbles at the glass layer interface that would otherwise be expected to occur. Use of flint glass as the casing glass layer overcomes the problems that would otherwise be associated with use of amber casing glass as discussed above - i.e., low radiation heat transfer characteristics, formation of seeds and blisters, and attack on precious metals employed in the glass melting system. The increased optical transmission of the overall container sidewall can be overcome, if needed, by decreasing the optical transmissibility of the amber glass inner layer - i.e., by increasing the intensity of the amber coloration.

There is thus provided in accordance with the present invention a method of forming a glass container that includes the steps of forming a cased glass stream that includes a core glass surrounded by a casing glass, with the core and casing glasses being of chemical compositions that react with each other at molten glass temperatures. Specifically, in the

preferred embodiment of the invention, the glass stream includes a reduced core glass, preferably amber glass, and an oxidized casing glass, preferably flint glass. In the preferred implementation of the invention, the cased glass stream is formed into a glass container by cutting a mold charge gob from the stream and molding the gob into a laminated glass container sufficiently rapidly that 5 the glasses do not have an opportunity to react with each other. When implementing the invention in conjunction with an individual section glassware forming machine, it is preferred to form multiple cased glass streams, multiple gobs and multiple glass containers simultaneously in each section of the machine.

In accordance with another aspect of the present invention, there is provided a 10 laminated glass container that comprises an inner layer of amber glass surrounded by an outer layer of flint glass.

Brief Description of the Drawings

The invention, together with additional objects, features and advantages thereof, will be best understood from the following description, the appended claims and the 15 accompanying drawings in which:

FIG. 1 is an elevational view of a laminated glass container in accordance with one presently preferred embodiment of the invention; and

FIG. 2 is a fragmentary sectional view on an enlarged scale taken substantially along the line 2-2 in FIG. 1.

20 Detailed Description of Preferred Embodiments

FIGS. 1 and 2 illustrate a laminated glass container 10 in accordance with one presently preferred embodiment of the invention as comprising an inner or core layer 12 of amber glass surrounded by an outer or casing layer 14 of flint glass. The term “amber glass” is employed in its conventional sense in glass technology as referring to a glass having an amber coloration that

reduces transmission of light through the glass container, which might degrade the product such as beer within the container. Amber glass is a reduced glass, typically having a redox number on the order of -20 or below. A currently preferred amber glass has the following composition:

Table 1

	<u>Analysis (Wt.%)</u>	<u>Properties</u>	
5	SiO ₂	72.173	Redox No. -27.7
	Al ₂ O ₃	1.711	Viscosity
	Na ₂ O	13.840	Log 2 2638.3
	K ₂ O	0.226	Log 3 2169.5
10	MgO	1.090	Log 7 1404.7
	CaO	10.351	Soft Pt. 1343.9
	TiO ₂	0.065	Ann. Pt. 1020.2
	SrO	0.009	Liquidus 1867.8
	SO ₃	0.161	Cool Time(s) 100.0
15	Fe ₂ O ₃	0.348	Ex. (0-300 deg) 88.3
	Cr ₂ O ₃	0.013	Dens. (gm/cc) 2.5036
	BaO	0.011	USPXXIII 7.1

This is a standard amber glass that has been employed by applicants' assignee for manufacturing
20 amber beer bottles.

The term "flint glass" (sometimes also called "clear glass") is likewise employed in its conventional sense to refer to a glass of essentially clear or transparent construction. Flint glass is an oxidized glass, typically having a redox number of zero or above. A presently preferred flint glass has composition and properties as follows:

Table 2

	<u>Analysis (Wt.%)</u>	<u>Properties</u>	
	SiO ₂	71.455	Redox No. 1.9
	Al ₂ O ₃	1.117	Viscosity
5	Na ₂ O	11.274	Log 2 2601.2
	K ₂ O	0.152	Log 3 2159.4
	MgO	2.911	Log 7 1417.6
	CaO	11.360	Soft Pt. 1357.8
	TiO ₂	0.033	Ann. Pt. 1044.8
10	B ₂ O ₃	1.249	Liquidus 1972.6
	SO ₃	0.166	Cool Time(s) 95.6
	Fe ₂ O ₃	0.041	Ex. (0-300deg) 81.6
	Cr ₂ O ₃	0.000	dens. (gm/cc) 2.5128
	Li ₂ O	0.242	USPXIII 6.7

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This is a flint glass composition employed by applicants' assignee, in which the coefficient of thermal expansion has been lowered. The coefficient of thermal expansion for the core glass may be on the order of 88×10^{-7} inches/inch/ $^{\circ}$ C, while the coefficient of thermal expansion of the casing glass may be on the order of 82×10^{-7} inches/inch/ $^{\circ}$ C. In container 10 of FIGS. 1 and 2, amber 20 core glass layer 12 is on the order of 93 to 95% of the total container weight, and may have a thickness on the order of 0.040 inches. Flint glass casing layer 14 may have a thickness on the order of 0.005 inches. The flint glass and amber glass have essentially the same viscosity characteristics at the molten glass temperature at which the casing glass stream is formed, typically in the range of 2050 to 2200 $^{\circ}$ F.

25 U.S. Patents 4,740,401, 5,855,646 and 5,935,286 are exemplary of methods and equipment that may be employed for forming a cased glass stream in accordance with the present

invention. U.S. Patent 5,824,128 is exemplary of equipment for shearing the cased glass stream into individual mold charges or gobs, and U.S. Patent 5,683,485 is exemplary of equipment for distributing the gobs of molten glass to the individual sections of an individual section glassware forming machine. U.S. Patent 4,362,544 is exemplary of an individual section machine in which 5 charges or gobs of molten glass are formed into individual containers employing either a press-and-blow or a blow-and-blow forming operation. The individual machine sections are identical to each other, and are operated out of phase with each other to produce glass containers that are transferred by a conveyor to an annealing lehr. The disclosures of all patents noted in this application are incorporated herein by reference. The disclosure of the above-noted Simpson and 10 Myers publication is also incorporated herein by reference. When employing such equipment, the total time duration between forming the cased glass stream and cooling the formed container below molten glass temperatures is typically not greater than ten seconds. It is believed that the glass could be maintained above molten temperatures for as long as fifty seconds and produce satisfactory containers in accordance with the present invention.

15 There have thus been provided a laminated glass container and a method of forming the same that fully satisfy all of the objects and aims previously set forth. Several alternatives and modifications have been disclosed. Although the invention has been described in connection with flint glass over amber glass specifically, the principles of the invention are equally applicable to other glass combinations in which the redox numbers differ significantly, 20 such as amber over flint, flint over emerald green (redox number on the order of -5), flint over blue green (redox number on the order of -10), or flint over UVA green (redox number on the order of +20). The invention is most beneficially employed when the redox numbers differ by at least 20. Other alternatives and modifications will readily suggest themselves to persons of

ordinary skill in the art. The present invention is intended to embrace all such alternatives and modifications as fall within the spirit and broad scope of the appended claims.